# CLAIMS

[1] A wavelength converter, comprising a plurality of wavelength conversion layers respectively containing, as phosphors, at least one type of semiconductor ultrafine particles having a mean particle size of not more than 20 nm and at least one type of fluorescent substance having a mean particle size of not less than 0.1 μm in a resin matrix

[2] The wavelength converter according to claim 1, wherein the semiconductor ultrafine particles and the fluorescent substance are dispersed in a resin matrix, unevenly distributed in the form of layers and form a plurality of wavelength conversion layers

[3] The wavelength converter according to claim 1, wherein each of the semiconductor ultrafine particles is a semiconductor composition consisting of at least two or more elements that belong to the groups I-b, II, III, IV, V and VI of the periodic table

[4] The wavelength converter according to claim 1, wherein the band gap energy of the semiconductor ultrafine particles is 1.5 to 2.5 eV

[5] The wavelength converter according to claim 2, wherein the resin matrix is a substantially single resin layer

[6] The wavelength converter according to claim 1, wherein the surface of the semiconductor ultrafine particles is coated with surface-modifying molecules

[7] The wavelength converter according to claim 6, wherein the surface-modifying molecules have two or more silicon-oxygen bonds repeated

[8] The wavelength converter according to claim 6, wherein the surface-modifying molecules form coordinate bonds to the surface of the semiconductor ultrafine particles

[9] The wavelength converter according to claim 7, wherein the number of silicon-oxygen repeating units of each of the surface-modifying molecules is 5 to 500

[10] The wavelength converter according to claim 1, wherein the semiconductor ultrafine

particles have a mean particle size of 0.5 to 20 nm

[11] The wavelength converter according to claim 1, wherein the semiconductor ultrafine particles have core-shell structure

[12] The wavelength converter according to claim 6, wherein each of the surface-modifying molecules has at least one functional group selected from the group consisting of an amino group, a mercapto group, a carboxyl group, an amide group, an ester group, a carbonyl group, a phosphoxide group, a sulfoxide group, a phosphone group, an imine group, a vinyl group, a hydroxy group and an ether group

[13] The wavelength converter according to claim 12, wherein each of the surface-modifying molecules is provided with two or more side chains having the functional group

[14] The wavelength converter according to claim 13, wherein a side chain is at least one selected from the group consisting of a methyl group, an ethyl group, a n-propyl group, an iso-propyl group, a n-butyl group, an iso-butyl group, a n-pentyl group, an iso-pentyl group, a n-hexyl group, an iso-hexyl group, a cyclohexyl group, a methoxy group, an ethoxy group, a n-propoxy group, an iso-propoxy group, a n-butoxy group, an iso-butoxy group, a n-pentoxy group, an iso-pentoxy group, a n-hexyloxy group, an iso-hexyloxy group and a cyclohexyloxy group

[15] The wavelength converter according to claim 1, wherein the semiconductor ultrafine particles have light luminescence capability

[16] The wavelength converter according to claim 2, wherein the resin matrix is obtained by hardening a liquid unhardened material of a mixture of the semiconductor ultrafine particles and the fluorescent substance

[17] The wavelength converter according to claim 1, wherein a refractive index is not less than 1.7

[18] The wavelength converter according to claim 1, wherein the resin matrix is hardened by heat energy

[19] The wavelength converter according to claim 1, wherein the resin matrix is hardened by light energy

[20] The wavelength converter according to claim 1, wherein the resin matrix comprises polymer resin containing silicon-oxygen bonds in a main chain

[21] The wavelength converter according to claim 1, which generates fluorescence having at least two or more intensity peaks in the range of wavelengths of visible light

[22] A light-emitting device comprising a light-emitting element that is provided on a substrate and emits excitation light, and a wavelength converter that is positioned on the anterior surface of the light-emitting element and converts the excitation light into visible light wherein the visible light is output light, wherein the wavelength converter comprises a plurality of wavelength conversion layers respectively containing, as phosphors, at least one type of semiconductor ultrafine particles having a mean particle size of not more than 20 nm and at least one type of fluorescent substance having a mean particle size of not less than 0.1 μm in a resin matrix

[23] The light-emitting device according to claim 22, wherein the semiconductor ultrafine particles and the fluorescent substance are dispersed in a resin matrix, unevenly distributed in the form of layers and form a plurality of wavelength conversion layers

[24] The light-emitting device according to claim 22, wherein the plurality of wavelength conversion layers are disposed so that peak wavelengths of light converted in each wavelength conversion layer can be progressively shorter from the light-emitting element side toward the outside

[25] The light-emitting device according to claim 22, wherein at least part of band gap energy of the phosphors is smaller than energy generated by the light-emitting element

[26] The light-emitting device according to claim 22, wherein the wavelength converter comprises at least three wavelength conversion layers and each light converted in the three wavelength conversion layers has a wavelength respectively corresponding to red, green and blue

[27] The light-emitting device according to claim 22, wherein each of the wavelength conversion layers is composed of a polymer resin thin film containing the phosphors

[28] The light-emitting device according to claim 22, wherein phosphors contained in the wavelength converter are semiconductor ultrafine particles having a mean particle size of not more than 10 nm

[29] The light-emitting device according to claim 22, wherein the wavelength conversion layers containing the semiconductor ultrafine particles are disposed on the light-emitting element side and a peak wavelength of output light from the semiconductor ultrafine particles is larger than a peak wavelength of output light from the fluorescent substance

[30] The light-emitting device according to claim 22, wherein the peak wavelength of output light from the semiconductor ultrafine particles is 500 to 900 nm

[31] The light-emitting device according to claim 22, wherein the peak wavelength of output light from the fluorescent substance is 400 to 700 nm

[32] The light-emitting device according to claim 22, wherein the excitation light has a center wavelength of not more than 450 nm

[33] The light-emitting device according to claim 22, wherein the output light has a peak wavelength of 400 to 900 nm

[34] The light-emitting device according to claim 22, wherein the resin matrix is a substantially single resin layer

[35] The light-emitting device according to claim 22, wherein each of the wavelength conversion layers has a thickness of 0.05 to 1.0 mm

[36] The light-emitting device according to claim 22, wherein the wavelength converter has a thickness of 0.1 to 5.0 mm

[37] The light-emitting device according to claim 22, wherein the phosphors contained in the plurality of wavelength conversion layers are composed of approximately the same material and are respectively semiconductor ultrafine particles having different mean particle sizes

[38] A light-emitting device comprising a light-emitting element that is provided on a substrate and emits excitation light, and a wavelength converter that is positioned on the anterior surface of the light-emitting element and converts the excitation light into visible light wherein the visible light is output light, wherein the wavelength converter comprises a plurality of wavelength conversion layers respectively containing, as phosphors, at least one type of semiconductor ultrafine particles having a mean particle size of not more than 20 nm and at least one type of fluorescent substance having a mean particle size of not less than 0.1 μm in a polymer resin thin film or a sol-gel glass thin film

[39] A method of producing a wavelength converter comprises the steps of:

(a) dispersing at least one type of semiconductor ultrafine particles having a mean particle size of not more than 20 nm and at least one type of fluorescent substance having a mean particle size of not less than 0.1 μm in an unhardened material of resin

(b) molding into sheet-like shape the resin having the semiconductor ultrafine particles and the fluorescent substance dispersed, and dispersing the semiconductor ultrafine particles more on one principal surface side of the molded product, and the fluorescent substance more on the other principal surface side

(c) hardening the sheet after the semiconductor ultrafine particles and particles of the fluorescent substance are dispersed

[40] The method of producing a wavelength converter according to claim 39, comprising the step of synthesizing semiconductor ultrafine particles in a liquid phase and allowing silicone-based compounds in the liquid phase to coordinate, each of which is mainly composed of silicon-oxygen bonds and has a functional group selected from the group consisting of an amino group, a carboxyl group, a mercapto group and a hydroxy group, prior to the above-mentioned step (a)

[41] A method of producing a light-emitting device comprising the steps of:

providing a light-emitting element on a substrate; and

disposing the wavelength converter according to claim 1 so as to cover the light-emitting element